

MARS14 Simulation of FØ Lambertson Heating

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Temperature rise in a bronze liner of the Tevatron FØ Lambertson at injection is calculated via express MARS14 [1] simulations. The beam parameters and Lambertson geometry were provided by Petr Ivanov and implemented into the model. A 150-GeV proton beam RMS spot sizes are $\sigma_x=1.9$ mm and $\sigma_y=1.15$ mm. Total proton beam is 10^{13} ppp. The 0.4-mm thick liner is made of the Cu-Be bronze C17200 (Be 1.9%, Co 0.2%, Cu 97.9%, $\rho=8.25$ g/cm³). Effective horizontal distance from the beam center to the liner is $3\sigma_x=5.7$ mm. It follows from measurements that some fraction η of the proton beam is lost on the Lambertson over the first 100 turns. It means that one can estimate an instantaneous temperature rise ΔT from calculated energy deposition distributions. A corresponding instantaneous temperature after such a fast “scraping” is calculated then as $T = T_0 + \Delta T$, where $T_0 = 20^\circ\text{C}$. We assumed two values for the number of protons lost on the Lambertson: $\eta_1 = 5\%$ or 5×10^{11} , and $\eta_2 = 1\%$ or 10^{11} . Two conservative assumptions were made: a beam density distribution in the tail outside of the 3σ envelope is Gaussian, and these “tail” protons hit normally the upstream face of the Lambertson’s first module.

The calculations reveal that the maximum energy deposition – and temperature rise respectively – takes place in the liner in the horizontal plane at $z \sim 15$ cm from the entrance to the first module. Fig. 1 shows calculated energy deposition isocontours at $10 < z < 20$ cm. Longitudinal profiles of a maximum instantaneous temperature in the liner is shown in Fig. 2 for 5% and 1% of the beam hitting the Lambertson. One sees that even with rather conservative assumptions, the maximum temperatures do not exceed 67°C and 29°C in these two cases, respectively.

References

- [1] N.V. Mokhov, “The MARS Code System User’s Guide”, Fermilab-FN-628 (1995); N.V. Mokhov, O.E. Krivosheev, Proc. Monte Carlo 2000 Conf., p. 943, Lisbon, October 23-26, 2000; N.V. Mokhov, “Status of MARS Code”, Fermilab-Conf-03/053 (2003); <http://www-ap.fnal.gov/MARS/>.

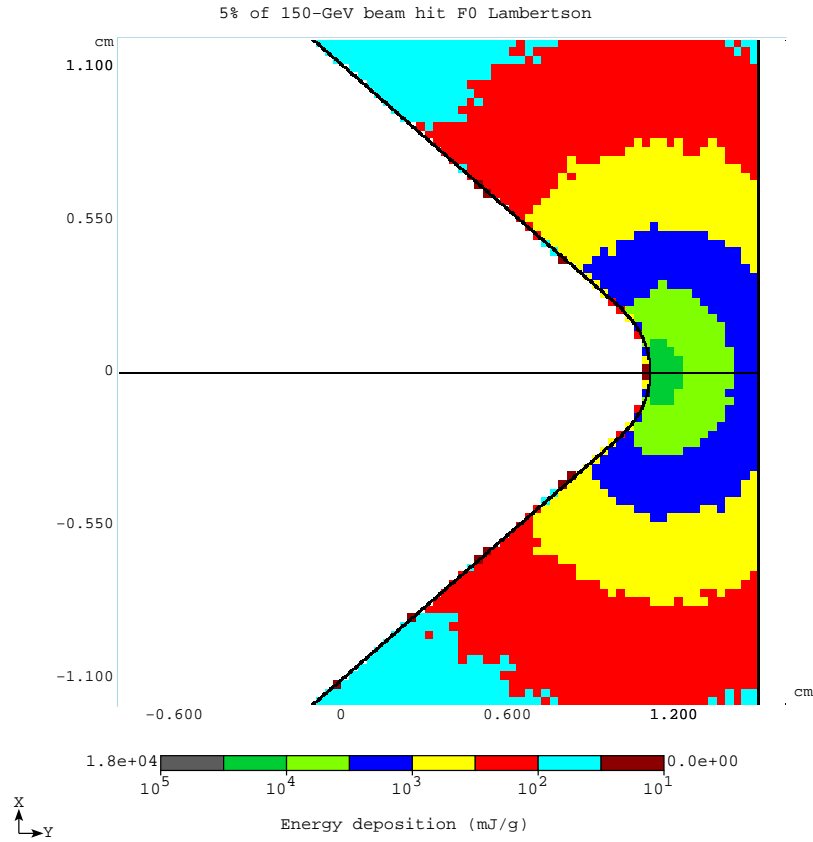


Figure 1: Energy deposition isocontours at shower maximum.

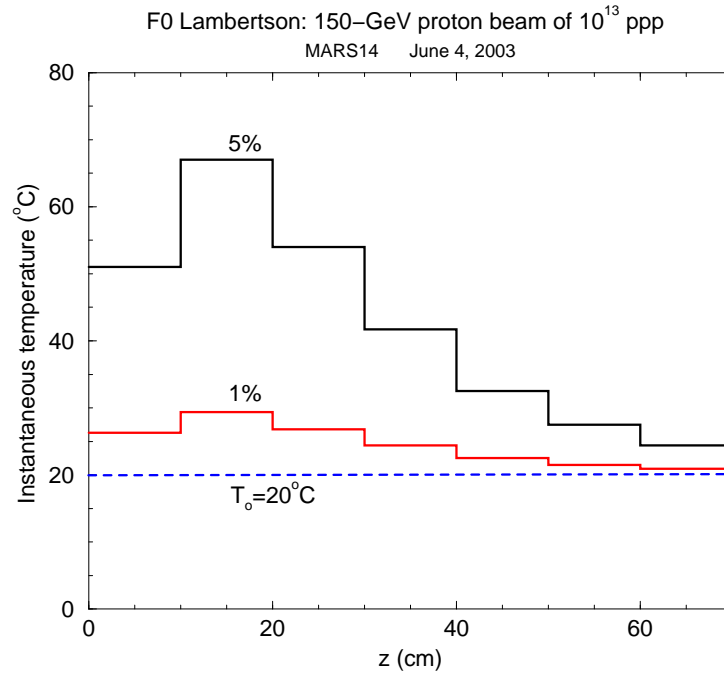


Figure 2: Longitudinal profiles of maximum instantaneous temperature in the liner.